DOCUMENT RESUME

ED 422 828 HE 031 586

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TITLE A New Focus for Institutional Researchers: Developing and Using a Student Decision Support System. AIR 1998 Annual Forum Paper.
PUB DATE 1998-05-00
NOTE 15p.; Paper presented at the Annual Forum of the Association for Institutional Research (38th, Minneapolis, MN, May 17-20, 1998).
PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS College Planning; Computer Software; Data Collection; Database Management Systems; Databases; *Decision Making; *Decision Support Systems; Higher Education; Information Retrieval; Information Storage; Institutional Administration; *Institutional Research; Management Information Systems; Planning; Research Directors; Systems Analysis; *Systems Development
IDENTIFIERS *AIR Forum; Metadata

ABSTRACT

Institutional researchers play a key role in an environment where data warehouses are used to store and retrieve vast amounts of data. Along with the benefits of increased access for more users, improved reporting capabilities, and less reliance on centralized information, come questions of appropriate data usage, data access and security, training, and on-going support. This paper discusses the development of a student decision support system at a university and the role played by the institutional research staff. Following the successful implementation of a data warehouse serving an employee and financial decision support system, development of a student decision support system was begun in January 1996. The paper outlines each step in the process, beginning with the decision model for the data to be included and a brief description of the technology. The following sections discuss implementation of the system, which included determining who should have access, security guidelines, and training potential users. Also discussed are data usage, analysis and reporting, on-going support, the student steering committee, standard queries, data validation, other support services, and metadata. Issues still to be resolved include an issue log, adding new data, software upgrades, and who organizationally will be responsible for on-going maintenance and enhancements. A user survey is appended. (Contains 6 references.) (CH)

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ED 422 828

A New Focus for Institutional Researchers: Developing and Using a Student Decision Support System

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Abstract

Data warehouses are becoming a popular way to store and retrieve data, particularly for colleges and universities. Ready access to vast amounts of data in an easy-to-retrieve format is simply too good to pass up. Along with the benefits of increased access to more users, improved reporting capabilities, and less reliance on centralized offices for information, come some liabilities. Appropriate data usage, data access & security, training, and on-going support become areas of concern. Institutional researchers will play a key role in this decentralized environment which will be different from the past when data access was often limited. This paper will discuss issues related to developing and using a student decision support system and how this will create a new focus for institutional researchers.

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This paper was presented at the Thirty-Eighth Annual Forum of the Association for Institutional Research held in Minneapolis, Minnesota, May 17-20, 1998.
This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of AIR Forum Papers.

Dolores Vura
Editor
AIR Forum Publications

A New Focus for Institutional Researchers: Developing and Using a Student Decision Support System

Decision makers in institutions of higher education need accurate, timely, and easily accessible information. In the past, it has often been the role of institutional researchers to provide this service. With information technology continually improving and academic and administrative staff in colleges and universities becoming more and more familiar with this new technology, the expectation of decentralized access to information has become ever higher. To meet this demand, institutions are developing ways to improve access to data which is easy to use yet flexible enough to meet the needs of a variety of users.

Increasingly, data warehouses are being used to store data that were previously only available on legacy mainframe systems to a limited number of specifically trained individuals. These data warehouses provide data that support the decision making of management. While institutional researchers may or may not be directly involved in the specific choices of the hardware and software used in a data warehouse, it is certain they will be called upon to share their knowledge of data as well as their expertise in reporting and data analysis when new systems are developed.

Institutional research as a profession has typically been a centralized administrative function which provides decision makers with data analysis and reports to answer specific, detailed, and often urgent questions. Institutional research offices have experienced staff who are available on demand for report preparation and data analysis. It is likely the role and function of the job responsibilities for institutional research professionals will change as institutions decentralize access to data and the culture of decision making changes (Matier, Sidle, & Hurst, 1995). The new responsibilities and the support institutional researchers will be asked to provide are the focus of this paper along with a description of how the student decision support system was developed at our institution.

Developing A Student Decision Support System

In 1992, our university began developing an Administrative Computing Master Plan. Two years later, the idea of a Decision Support System (DSS) surfaced as a response to the need for direct data access by multiple users. At the time, information used for management decisions was largely serviced by staff in the central administrative offices who were responding to an overload of requests from the academic community. It was thought that management decision making could be enhanced by providing access to data by knowledgeable staff in multiple offices across the campus. The first Decision Support System with increased access to users included employee and financial information. This data warehouse project began 1993 and was fully functional to users within two years. The users of the Employee and Financial DSS information are primarily business analysts who are in administrative budget positions in both academic and administrative offices.

After the successful development of the Employee and Financial DSS, the next information identified to be included in the data warehouse was the student data. It was at this point in time when staff from the student data research area were called upon to join the project team along with staff from Management Information to participate in the development of the student data warehouse. Development of the Student DSS was in full swing by January 1996. With a total of

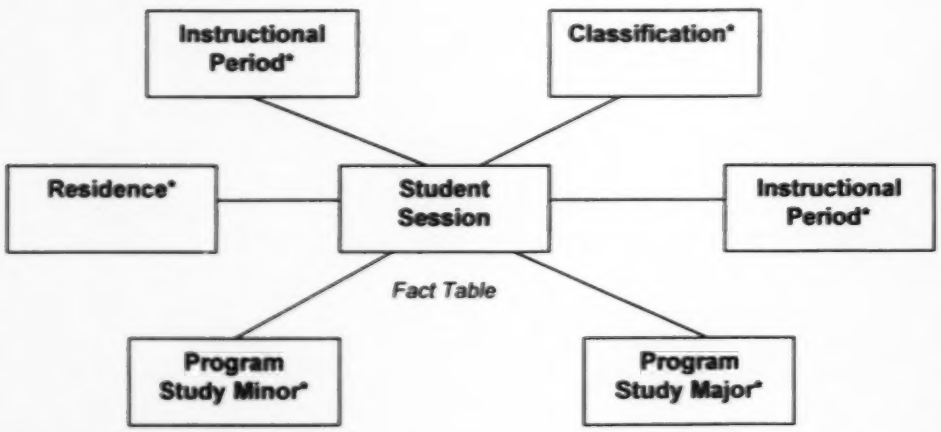
nine full-time staff, plus consultants, executive sponsors, and a steering committee, the system prototype was finished within 12 weeks.

The Student DSS Models

One of the first things considered for the Student DSS model was what data to include in the data warehouse. Prioritizing what information from the legacy systems to include was the first step. Consideration of the most frequent types of student requests currently serviced by the student data research area were identified and any additional types of data requests based on the experiences the staff were also considered. Five models evolved from these discussions: 1) Student Session; 2) Student Course; 3) Student Academic Award; 4) Student Program Change; and 5) Student Standard Test Scores.

The data modeling is based on Edelstein's (1995) star join model. This model consists of two types of tables: 1) fact and 2) dimension. All of the five models mentioned above are organized in this manner. The fact tables contain data that changes on a frequent basis and is the centerpiece of the model. The Student Session Model shown below, contains the Student Session Fact Table which contains variables that change each semester such as registration status, semester index, registration school, etc.

The Student Session Fact Table is joined by supporting dimension tables which contain information that remains relatively constant, such as demographic information about the student, the student's classification (year in school), residency groupings, and program of study reference information. These dimension tables also contain text translations of coded information like academic school groupings. The Student Table, containing pre-college and personal information is included in all of the models.



DSS Student Session Data Model

Technology

The data warehouse is housed in an Oracle database on a university server. The data can be retrieved by using Oracle query tools, such as Brio Query Software or other software packages that support open database connections such as SAS, Access or SQL Plus. Our reporting tool is Brio which works in a Windows environment and is relatively easy to learn and fairly flexible in generating reports. By "pointing and clicking," the user can choose the appropriate variables and data. One query may lead to other queries and eventually the user may find him or herself addicted to easy data access. Not only is it designed to provide quick and accurate responses to user's queries, but also customized reports, graphs, and tables can be readily prepared. Brio can also be used to export results to a spreadsheet or text file.

To use DSS an IBM compatible computer with Windows 95 or higher or a Macintosh PowerPC is required. The IBM must be a minimum of a 486 with a RAM of 16 MB and 540-MB disk space, while the Macintosh must be, at least, a PowerPC 601 with 16 MB of RAM and 230 MB of disk space. In addition, the PC must be connected to the campus backbone.

Implementation of Student DSS

Prior to the actual training of users, two extremely important issues of access and security needed to be addressed. These topics are described below followed by a description of our training regime.

Access

Determining who should have access and for what reasons are important considerations. At our institution, access is limited only to those who have been identified by their dean or department head and only after they have gone through the training. The Student Services Data Steward (a steward responsible for data definition, access authorization, and physical data storage and integrity) authorizes access to the information and a document specifying the type of access and the approving signatures is kept on file.

There are three main prerequisites to DSS access. First, there must be a business need for the data. The user must confirm that the information is required to assist him or her in pursuing student and university education or vocational objectives. Access is granted to those staff members who need the information resources required to carry out the responsibilities of their position.

Second, the user is accountable for the security of the student information they access. The user assumes responsibility for evaluating the requests they receive and they are responsible for maintaining appropriate records regarding the request. The user must determine if the recipient is authorized to receive the information, and if so, must then inform the recipient of the responsibilities that accompany the results.

Third, users must complete the required training program before being granted access. They will be appropriately trained in the use of the student information and will also be given a training manual that will not only provide general information and details on the data, but the procedures and guidelines they must adhere to.

Security

Institutional researchers understand the importance of maintaining the security of data. The Family Education Rights and Privacy Act (20 U.S. code & 1232g) (FERPA) is designed to protect the privacy of students' educational records and personally identifiable information and describes the rights of students and the responsibilities of educational institutions. Our university has a written policy about the release of student information which mandates that, aside from directory information, all education records and personally identifiable information are kept confidential. Such information cannot be released without the student's prior written consent except in certain situations such as for use by school officials and organizations or for reporting to federal, state, or local agencies. Not only is this guidance outlined in the training manual, but the user also receives a copy of a pamphlet explaining the FERPA regulations.

Since not all users need access to *all* of the data, there are two types of views available (Miselis, 1990). To gain access to either requires the approval of the dean or department head and Student Services Data Steward. The two data views offered are the **general** and the **complete** view. The **general** view does not include personally identifiable information such as name, social security number, and address. Those who use the **general** view are most often tying the Student DSS information with the Financial DSS. The **complete** view, as the name implies, offers access to all of the data. Those who sign up for Student DSS are most often given this view. Central offices, deans, and school officials, such as those that advise and provide assistance to students, use the **complete** view. For every query and for either view, a password is necessary further enhancing the systems' security.

Training

Training is a key element to the success of a Decision Support System, and is an activity in which institutional researchers will very likely be involved. Providing expertise on understanding the data as well as conveying the importance of data interpretation is a key element of the training regime.

Potential users need certain minimum skills prior to training including familiarity with Windows and database concepts. Additionally, the skill set inventory required for potential users is basic keyboarding and mouse maneuvering, knowledge of standard Windows applications and menu systems, navigating the World Wide Web using a browser, and creating and navigating sub-directories. It is also helpful if the user knows how to transfer files through FTP, has experience with on-line systems, and has experience using either a database or a spreadsheet.

Originally, two client groups were targeted for training in Student DSS: administrators in central offices such as Financial Aid, Admissions, the Graduate School, and academic advisors in the various academic schools. There are two basic components of the Student DSS training: how to use the software and how to understand and interpret the data.

The software training begins with a four hour Brio session that covers the basic principles of how the software operates. The user becomes familiar with the Windows environment by using financial information to develop queries and reports. Having completed the software training, the user then undergoes an additional 14 hours of training to understand the student data.

Though it may seem easy to get initial results, the user will find it more challenging to get accurate and meaningful information. Therefore, developing data knowledge is the most important aspect of becoming a successful DSS user. This is demonstrated by the amount of training time spent on developing data knowledge: 14 hours compared to the four hours spent on software training. Research staff play a key role in making certain that new users fully appreciate the importance of understanding data and interpreting results.

The first training session, the orientation session, covers the structure of the data and its models, the metadata, and an overview of the nature of Student DSS. The following sessions look at the individual models and use examples of existing queries, reports, and requests, while the user learns how to gather the accurate information and correctly interpret the results. The final training session addresses advanced techniques, FTP procedures, and personalized queries in which the user may use requests they receive in their position to practice developing successful queries.

A need has recently been identified for training users at the executive level such as department heads and deans. These individuals do not have the time needed to complete the full training courses described above, but have a desire to use the Decision Support System. An executive training program is being developed to train these individuals. The focus of the training will be on the data with a brief session on the reporting tool – Brio. It is assumed that these individuals already have a working knowledge and understanding of the data.

Using DSS

Data Usage

Central offices use Student DSS to answer a variety of ad-hoc requests and surveys. Typical queries include enrollment for a specific sub-group or sub-groups. For example, developing a query of the official fall enrollment for only those students who are full-time freshmen in engineering with SAT scores of more than 1000 is easy. Relatively simple queries become more complex with longitudinal and comparative analysis. Historical data back to 1991 on a semester basis is available for all models except for the Academic Award model which goes back to 1987.

Student DSS can also be used for tracking purposes and has become a useful tool for academic advisors. For example, being able to identify courses which work best as prerequisites for other courses and which combination of courses work well with each other is useful information. Profiles of successful students in specific courses can also be determined which can be an important advising tool. With information such as SAT scores, high school rank, and previous grades, the academic advisor may find which academic track will work best for their students. The academic advisors are also interested in the students who change their major. Advisors want to know which schools the students are coming from, what type of students are changing majors, and which school their students changing to. The information that these queries provide help the academic advisors develop plans for student retention and success, and enable them to make better decisions when advising individual students.

Analysis and Reporting

With Brio, data from Student DSS can be analyzed and reports can be presented in a variety of ways. When creating queries, it is easy to set limits on variables. Limiting data returned

to a specific year and term are typical. Structured Query Language (SQL) can be used to create customized limits and mathematical functions can be applied.

Pivot tables are used to create the reports once the data have been processed and the results have been returned. In the pivot tables, variables can be grouped, variable names can be changed, and report headers and footers can readily be inserted. Text formatting is also a valuable and useful feature. Subtotals and grand totals are easy to add as are the percentages of columns, rows, and grand totals. Even a percentage increase is easy to include. Data can be sorted in alphabetical order from A to Z or from Z to A. Numerical data can be sorted either in descending or ascending order. Data can be presented horizontally or vertically across just by moving the label of the variables to the desired location. Best of all, the pivot table technology makes it possible to create multiple pivot tables within the same query. With just one query, multiple reports can be created to meet varying needs.

External datasets can also be merged into Brio queries. With a set of student ID's from an external source, a query can be designed using these individuals by matching their ID's to the DSS data. This expands the power of this reporting tool immensely.

If tools other than Brio are used to access the Oracle database, additional analysis can be preformed. If SAS is used for example, there is the potential for sophisticated statistical analysis. Having historical information available in a database in combination with different software packages for accessing the data, provides the opportunity for very powerful analysis and limitless reporting capabilities (Miselis, 1990).

On-going Support

Institutional researchers will find many roles to play in a decentralized data access environment. By focusing on access, user support, information and knowledge development McLaughlin, McLaughlin, and Howard (1987) maintain that institutional researchers should be able to provide and coordinate support for decision support systems and continue to meet the needs of the various users throughout the university. McKinney, Schott, Teeter and Mannering (1987) address the need for institutional researchers to play a role in data administration that would coordinate matters relative to data resources with the primary intent of enlightening users "in order to minimize bias and contradictory reporting of data" (p.74).

Whether it is serving on a steering committee, developing standard queries, query validation, consulting, training or servicing ad hoc requests, institutional researchers' role in supporting the continued success of a decision support project is crucial.

Student DSS Steering Committee

A steering committee was formed as soon as the prototype models were converted to production. It consists of one person from each of the academic schools and representatives from several central administrative offices (including a research staff member). Their charge is to: 1) oversee the implementation of the Student DSS campus-wide, 2) manage the system components (such as ensuring data integrity), and 3) communicate the status of the projects to the DSS community. This committee meets on a monthly basis.

Recently, the Student DSS Steering Committee conducted a survey of people who had been trained in Brio/DSS. The specific intent of the survey was to identify and better understand any barriers that users might be encountering and to determine if user's needs were being fully met. A series of questions asked about the frequency of use of Brio/DSS. Another set of questions asked about specific barriers users might be coming up against. A total of 122 trained users were surveyed. Clients were mailed a two-page survey asking for feedback on the issues stated above. A follow-up mailing was sent to all non-respondents.

Overall, 81 individuals responded for a response rate of 66.4%. Of these 81, 25 indicated that they had not used DSS since their training while 56 indicated that they are currently using DSS. Finding enough time to work on DSS was a concern for many. Current users indicated overwhelmingly that they could answer the questions they wanted to answer and that they felt confident with the results they have gotten using DSS (see Appendix A for a summary of the results).

Standard Queries

Another role in which institutional researchers are likely to play is the development of standard queries. These queries are developed to respond to frequently asked questions or to create a report which replicates information from the university's official reports. Once standard queries are created and verified, they are considered an "official" query and placed in a directory that is accessible to all users. DSS users can use these "official" queries for an accurate representation of the official reports. The standard queries that were initially designed for a particular school may be adopted by others with similar questions. As each refresh (data warehouse update) occurs and data are added or modified, queries must be updated and verified. With users being able to modify the queries that have been validated to reflect official reports, the reliance on research staff to provide this service decreases.

Data Validation

The data warehouse is updated on a regular basis, typically two to three times a semester. Once this refresh has occurred, it is necessary to determine whether or not the refresh has been successful. Past experience has shown that with this relatively new system, problems with the data can occur. Establishing a process to validate the data and ensure that the models are functioning correctly is an ongoing process. Specifically designed queries are used to validate the refreshed data. Because institutional research offices have knowledgeable staff who are experienced using the data, they may be called upon to create and run these queries. The consistency and integrity of the data is a major concern and currently involves substantial effort.

Other Support Services

There are monthly query clinics, monthly user group meetings, an e-mail list serve, a web page, an on-line bulletin, and mentoring that all serve to help the users become efficient and effective with their queries. At the query clinic the user can bring in problematic queries and receive one-on-one consultation. The user group meetings are a forum for discussing updates or changes to the data models and software. Additionally, it serves as a forum to discuss any problems that have arisen and an opportunity to discuss query design. The list serve delivers quick

information for daily or weekly issues to all who have been trained in Student DSS. Directories are also available for query sharing. Problem queries can be placed on this directory and the support staff can view the query and makes suggestions or adjustments. Another directory stores the queries that replicate official reports. A web homepage has been created that offers on-line basic descriptions of DSS, its history, Brio frequently asked questions, updates on the software or data, access request form, prerequisite checklist, technical support, and tips and techniques. An on-line bulletin board offers users a tool to post questions and receive answers about DSS or Brio. Mentoring is available and matches new users with experienced users for more personalized assistance. The training manual is also available which serves as a continuous resource for ongoing training. (The Student DSS Web Site is: http://www.adpc.purdue.edu/WAI/student/studss.htm.)

Metadata

An important training feature of DSS is the metadata -- data about data. The metadata serves as an authoritative source for information about the data available in the data warehouse. The metadata for this project is available on the web and is very easy to access, especially for those who need a quick reference. The users can locate detailed definitions for every field in the Student DSS data models and tables. They are encouraged to go to the metadata via the web each time they are introduced to a new model and refer to information on specific fields or dimension tables. There they may also use the web in search of facts about a particular type of data. The users are encouraged to bookmark the relevant pages that they use most often. This enables them to speed through the data and make it even more user friendly when developing new queries. With the metadata available on the web the users does not need to remember all the details of the fields in DSS. The information available in the metadata serves as a valuable resource and can be used as an on-going training tool.

Unresolved Issues

While many improvements and changes have been made to DSS since the project began, there are a number of matters that continue to need attention. Summarized below are issues that remain unresolved and how we are addressing them.

Issue Log

An issue log is maintained that tracks active and pending issues. Approximately 150 issues have been logged to date. Issues identify problems with data, performance, and the models. These issues are evaluated by the project team as to the resources needed to complete the task and then prioritized by the Student DSS Steering Committee. As time goes one, it is anticipated that the number of active issues will decrease.

New Data

User feedback has indicated that a cohort model is needed. Determining the average time to graduate and retention rates for various cohorts of students is of interest to many. Tracking of both undergraduate and graduate students will be possible with the cohort model that is currently in testing. Users have indicated they would like to see additional data added to Student DSS including: admission's data, previous college information, financial aid information, athlete data,

and advisor codes. Addition of new data is dependent upon the availability of resources which is not a certainty.

Software Upgrades

Like other software, Brio has new releases. Each new release must be tested and the differences from the previous version identified to determine the amount, if any, of training users will need with the updated release. Additionally, with the variety of hardware and operating systems, it is no small task technically to do these upgrades. Developing a process to update equipment with Brio 4.0 to Brio 5.0 is currently underway.

Organizational Structure

On-going responsibility for maintenance and enhancements of DSS is an issue. The original members of the project team from our computing center will be assigned to new responsibilities in the near future. How current issues will be resolved on an on-going basis is a concern. Also of concern is how new models will be developed. Currently, there is one full-time business analyst assigned to do training and trouble-shooting. Technical assistance comes from respective local area network managers. Training is primarily conducted by the business analyst and the data steward along with help from previously trained users. Asking the users to be responsible for training on a regular basis is not an ideal situation.

Almost all of the individuals trained in Student DSS have job responsibilities that do not include preparing reports on student data or responding to ad hoc requests. Many users were trained so they could personally make more informed decisions or provide decision-makers with needed information. Some individuals have reported that while they see information they retrieve from DSS as being useful, they simply do not have the time to devote to such activities given their other job responsibilities. With Financial and Employee DSS, there is a much clearer organizational structure that includes incorporating DSS use as part of the job, but the line is not as clear for many Student DSS users. Not having enough time to work on queries and keeping skills current is a major concern for many of our users. Having a significant pool of users to justify the system is a concern.

Summary

The information available in Student DSS has certainly improved the ability of the research staff to prepare reports and analyze data. At the same time, it has also required that we refocus our energy to provide support for training, data validation, issue resolution and consulting. Additionally, this decentralized access to data has benefited many staff who now have the opportunity to extract and use data. Having one source of data accessible to all relevant parties diminishes arguments about whose data are "right" Matier, et al. (1995). Hopefully, this change will also improve the potential for good decision making.

The Student Decision Support System is still in development. Work on key issues such as refreshing the data, fixing data errors, training new users, developing standard queries and managing access is on-going. Institutional researchers have been and will continue to be critical players in all of these areas. What is certain is that institutional researchers will continue to play an important role in providing service to many even as our roles change and as we refocus our responsibilities.

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Appendix A

STUDENT DSS USER SURVEY
March, 1998

A survey of Student DSS users was conducted in early 1998 at the behest of the Student DSS Steering Committee. The specific intent of the survey was to identify and better understand any barriers that users might be encountering and to determine if user's needs were being fully met.

A series of questions asked about the frequency of use of Brio/DSS. Another set of questions asked about specific barriers users might be encountering. Additional questions asked if they were able to answer the questions they needed to answer using Brio/DSS, if they were confident in the results returned using Brio/DSS, if they were able to combine external data with DSS data, if they were any other models they would like to see developed, and if the group meetings were useful. One final question asked for any additional comments, suggestions or concerns.

A total of 122 trained users were surveyed. Clients were mailed a two-page survey asking for feedback on the issues stated above. A follow-up mailing was sent to all non-respondents. Overall, 81 individuals responded for a response rate of 66.4%. Of these 81 who responded, 25 indicated that they had not used Brio/DSS since their training while 56 indicated that they were currently using Brio/DSS.

The results below summarize the responses from the 56 individuals who are using Brio/DSS. Percentages of users who responded are given in the various categories. These responses are for the closed-ended questions. The results that contain the summary feedback from the open-ended questions are presented elsewhere.

FREQUENCY OF USE
Responses for Clients Currently Using BRIO/DSS
(N=56)

Percent of Respondents

	Daily	Weekly	Monthly	Occa-sionally	Never
1. *use BRIO/Student DSS*	11%	30%	45%	7%	7%
2. *get requests for data retrieval from BRIO/Student DSS*	7%	24%	42%	11%	16%
3. *use the Student DSS metadata*	2%	19%	31%	10%	38%
4. *use shared queries*	0%	2%	21%	4%	73%
5. *access/exchange files on the FTP server*	4%	5%	20%	15%	56%

BARRIERS EXPERIENCED
Responses for Clients Currently Using BRIO/DSS
(N=56)

Percent of Respondents

	Always	Usually	Occasionally	Rarely
6. *"bad" or inaccurate data returned*	0%	6%	71%	23%
7. *don't understand data*	0%	2%	43%	55%
8. *no time -- other job responsibilities need attention*	15%	50%	27%	8%
9. *trouble connecting to DSS (Oracle errors)*	4%	6%	33%	57%
10. *hardware problems (machine doesn't work)*	2%	2%	10%	86%
11. *problems merging external data sets*	2%	10%	14%	74%
12. *trouble exporting queries to Excel*	2%	4%	13%	81%
13. *don't know if queries are right or not*	4%	12%	53%	31%
14. *can't get the answers I need to Brio questions from support staff*	4%	2%	16%	77%
15. *difficulty using FTP server*	6%	9%	15%	70%
16. *metadata doesn't answer my question*	0%	4%	36%	60%
17. *can't get answers to data questions from support staff*	2%	4%	11%	83%
18. *don't know where to find data update (refresh) information*	4%	9%	22%	65%

Success Using Brio/DSS
Responses for Clients Currently Using BRIO/DSS
(N=56)

Percent of Respondents

	Yes	No	Haven't Tried or Don't Know
Have you been able to answer the questions you have wanted to answer using BRIO/Student DSS?	83%	6%	10%
Do you feel confident with the results you have gotten using BRIO/Student DSS?	70%	17%	13%
Have you needed to combine data from BRIO with data from other sources in order to fully answer questions?	47%	41%	12%
Is there any information not available in the current models that would be helpful to answer your questions?	26%	21%	52%